Estimating the Economic Impact of Secondhand Smoke on Indiana in 2007

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ABSTRACT

Introduction: This study provides estimates of the health-related costs of secondhand smoke exposure to the residents of the State of Indiana.

Methods: Costs of secondhand smoke-related mortality and morbidity were estimated using national attributable risk values for diseases that are known to be causally related to secondhand smoke exposure for adults and for children. Estimated costs included ambulatory care costs, hospital inpatient costs, and loss of life costs based on vital statistics, hospital discharge data and census data. Attributable risk values were applied to the number of Indiana deaths and hospital discharges in 2006 to estimate the cost of hospitalizations for individuals impacted by secondhand smoke exposure in 2007.

Results: The overall cost of health care and premature loss of life attributed to secondhand smoke for Indiana residents was estimated to be \$390.3 million in 2007 --\$68.3 million in health care costs and \$41.5 million in loss of life for children compared to \$214.2 million in health care costs and \$66.3 million in loss of life for adults. The estimated population for Indiana in 2007 was 6,345,289 resulting in secondhand smoke related costs of \$61.51 per capita in 2007.

Conclusions: The results of this study provide data estimates needed to educate the public, community leaders, and state policy makers about the health effects and costs of secondhand smoke exposure in Indiana.

INTRODUCTION

Exposure to secondhand tobacco smoke (SHS), also known as environmental tobacco smoke, passive smoking, and involuntary smoking, is a significant contributor to adult and childhood morbidity and mortality in the United States. 1-4 Secondhand smoke is a complex mixture of gases and particles comprised of smoke from burning cigarettes, cigars or pipe tobacco (side stream smoke), mainstream smoke that is not inhaled by the smoker, and exhaled tobacco smoke. Side stream smoke and mainstream smoke contain the same chemical constituents including at least 250 chemicals known to be toxic or carcinogenic. Exposure of nonsmokers to secondhand smoke in adulthood has been causally associated with many medical conditions, including lung cancer, nasal sinus cancer, breast cancer, cervical cancer, ischemic heart disease (myocardial infarction and arteriosclerosis), stroke, eye and nasal irritation, spontaneous abortions and asthma.²⁻⁵ In addition, other studies have suggested that exposure to secondhand smoke may be causally associated with adult leukemia, angina pectoris, hearing loss, allergies, periodontal disease, dysmenorrhea, colds, pneumonia, meningococcal disease, macular degeneration, congestive heart failure and cardiac arrhythmia.^{2,7-22} Exposure of children to secondhand smoke has been linked to low birth weight, sudden infant death syndrome, respiratory syncytial virus bronchiolitis, asthma exacerbations, otitis media, chronic respiratory symptoms, cystic fibrosis exacerbation, Legg-Perthes disease, allergies, meningococcal disease, loss of hearing and cognitive behavioral impairment.^{2-4, 12-13, 15-16,} ²³⁻²⁷ Also, many children⁴ and adults are injured from fires started by smoking. The Centers for Disease Control and Prevention report that any level of exposure to SHS can be dangerous ²⁸.

Secondhand smoke exposure continues to be a major public health concern. First, about one-fifth (19.8%) ^{29, 30} of the adult US population smoke. More of the adult current smokers are male (21.2% male) between the ages of 18-34, are

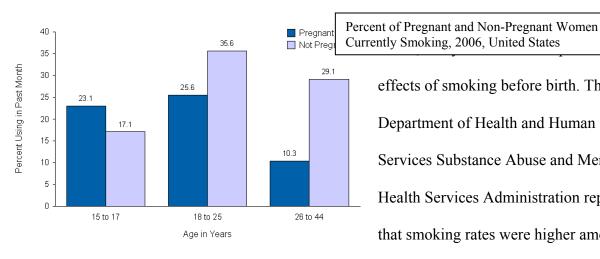
Black/African-Americans

(21.7%), earn less than \$25,000

Behavioral Risk Factor Surveillance System, 2007 Adult Smokers in Indiana and the United States

	Indiana	United States
Adults who are current smokers	24.1%	19.8%
Males who are current smokers	25.9%	21.2%
Females who are current smokers	22.5%	18.4%
18-24 years of age	29.8%	24.0%
25-34 years of age	30.7%	23.9%
35-44 years of age	25.8%	20.4%
45-54 years of age	27.2%	22.3%
55-64 years of age	21.7%	18.0%
65 year of age and older	9.5%	9.0%
White	24.0%	19.4%
Black	22.9%	21.7%
Hispanic	25.1%	16.7%

per year, and have less than a high school education (33.2%). The trends are the same for Indiana, except more of the current smokers are white (24.0%). These data suggest that there are still significant opportunities for non-smokers to be exposed to secondhand smoke.



effects of smoking before birth. The Department of Health and Human Services Substance Abuse and Mental Health Services Administration reports that smoking rates were higher among

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those who were pregnant and between the ages of 15-17 (23.1% pregnant versus 17.1% not pregnant). Furthermore, the combined 2005 and 2006 data show that about 16.5% of pregnant females report "cigarette use during the past month". ³¹

Third, it has been estimated that nearly 60 percent of the children in the United States children are exposed to SHS in the home.²⁸

Although much work has been done to protect non-smokers from the deleterious effects of SHS with about 65% of the U.S. population and 40% of the Indiana population being protected by smoke-free laws as of April 2008 ³² and numerous studies have reported the link between secondhand smoke exposure and morbidity and mortality among both adults and children have been published, little is available in the scientific literature regarding the economic consequences of these adverse health effects.

The purpose of this report is to estimate the costs of health care and premature loss of life resulting from secondhand smoke exposure in the State of Indiana

METHODS

Costs of secondhand smoke-related mortality and morbidity were estimated for 2007 using national attributable risk values for diseases that are known to be causally related to secondhand smoke exposure for adults and for children. Estimated costs included ambulatory care costs, hospital inpatient costs, and loss of life costs based on vital statistics, hospital discharge data and census data. Attributable risk values were applied to the number of deaths and hospital discharges in 2006 (last year available) to estimate the number of individuals impacted by secondhand smoke exposure.

This study used national research-based attributable risk values, community-based demographic data from the U.S. Census Bureau (for 2000 and projections to 2007),

disease incidence in the community (i.e. disease-specific hospitalizations in 2006), average hospital charges for the selected diseases, and an estimated economic value of life. The estimated attributable risk values were obtained from articles and reports identified in searches of major literature databases. Of these, three were primary sources used for this study: the 2005 California EPA Report, the 2006 Surgeon General's Report³ and a study conducted by Aligne and Stoddard.⁴ The major data source was the California EPA (CalEPA) report, which provided the basis for many of the health effects cited in the 2006 Surgeon General's Report.³ The CalEPA report summarized several research studies that presented values based on thorough reviews of meta-analyses. literature syntheses, and epidemiological studies in the U.S. and industrialized countries. Peer-review publication and frequency of article citations were also considered by CalEPA in selecting articles used as sources of the attributable risk values. When more than one value was presented in the CalEPA report, this study used the best or median estimate, not the highest. Furthermore, the sources used in the CalEPA report considered sample sizes of the studies, the extent to which the studies accounted for confounding factors, selection bias when comparing groups, bias in ascertaining exposure, and generalizability to the U.S. population.

Questionnaire-based assessments of exposure to secondhand smoke are the most widely used method to evaluate individuals' exposure to tobacco smoke. Questionnaires have important advantages: they are relatively inexpensive; they can be feasibly administered in a variety of ways, including mail surveys, telephone surveys, or in person; and they are able to assess both current and past exposures. The disadvantages include difficulties in validation, particularly of a past exposure, and the potential for

misclassification.³³⁻³⁴ Measures of exposure in the studies included in the CalEPA report were often based on self-report questionnaire based assessments. However, the 2006 Surgeon General's Report³ focuses on the importance of using biomarkers to assess exposure. Biomarkers are more specific and more sensitive, which are necessary qualities for program evaluation and community surveillance. Evidence suggests that prevalence of tobacco smoke exposure is significantly underestimated when using questionnaires.

Data from the Third National Health and Nutrition Examination Survey (NHANES III) showed a detectable level of cotinine in 88 percent of nonsmoking adults.³⁵ which is much higher than community studies of exposure to tobacco smoke.³⁶ A significant limitation of using biomarkers, however, is that biomarkers measure only current exposure, not lifetime exposure to tobacco smoke. Questionnaires can be used to measure historical exposure, although recall biases do exist. Finally, evidence shows that there is a strong correlation between both sources of exposure assessments.^{35, 37,41} Thus, while use of biomarkers may be preferred, well-designed questionnaires can produce valid results.

The attributable risk values used in the current study were based on research using current measures of exposure based on both questionnaires and biomarkers. While these decisions were dictated by available research, it is believed that the result actually yield more conservative measures of attributable risk.

Secondhand Smoke Adult Morbidity Costs:

The formula used to calculate the hospitalization costs for each specific attributable disease in adults was:

Hospitalization Costs = AR * H *CH

Where:

AR is the attributable risk of getting the disease if exposed to secondhand smoke;

H is the number of hospitalizations in Indiana for the specific disease;

CH is the average charge per hospitalization for the specific disease, adjusted to 2007 dollars.

Attributable risk values used in this study for specific diseases were specified in the CalEPA report.² For a few conditions, when multiple attributable risks were reported, the attributable risk from the study with the strongest design and largest number of subjects was used. The number of hospital discharges and hospitalization costs for the specific diseases were obtained from annual hospital discharge summaries prepared by the Indiana Hospital Association and provided to the Indiana State Department of Health.

Limitations in Estimating SHS Adult Morbidity Costs: The major limitations that affect the validity of this approach to estimate adult morbidity costs relate to data gaps and underlying assumptions. First, annual costs of outpatient care, emergency room care, and prescriptions for the specific diseases were not available and were excluded from this component of the cost estimates. Second, costs of pain and suffering were not included in this model. Third, only those diseases with well-documented attributable risks for secondhand smoke exposure were included. Future studies may identify additional diseases consistently attributable to secondhand smoke exposure as well as more valid values for the attributable risk values. Fourth, this model assumed that the percent of costs attributed to treatment of the specific diseases caused by secondhand smoke exposure is the same as the percent of cases of disease that are attributed to secondhand exposure. Finally, it was assumed that the attributable risk values found in the published literature apply to the population in Indiana.

Secondhand Smoke Adult Mortality Costs:

The mortality costs for each condition attributed to secondhand smoke were calculated using the following formula:

Loss of Life Costs =
$$AR * D * VL * [(LE - AD)/LE]$$

Where:

AR is the attributable risk of getting the disease if exposed to secondhand smoke;

D is the number of deaths in Indiana for the specific disease;

VL is the estimated value of a full life (\$3,612,230 -- inflated to 2007 value);

LE is the life expectancy; and,

AD is the average age of death for the specific disease.

The term [(LE - AD)/LE] estimates the proportion of a person's life that is lost due to premature death.

The information needed to calculate these costs included: the disease-specific attributable risk for secondhand smoke exposure, the number of deaths for the specific diseases (based on Indiana death certificates for 2005 deaths), an estimate of the value of life, life expectancy (reported by the National Center for Health Statistics based on 2004 deaths), and the average age at death for the specific diseases. The same attributable risk values were used for the loss of life estimates as for the costs of hospitalization.

To determine the loss of life costs, the estimated monetary value of life was obtained from the United States Department of Transportation.⁴² The guidance recommended that the value be set at \$3,000,000 in 2000. This value was inflated by the

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consumer price index to \$3,612,230 in 2007 using the US Department of Labor consumer price inflator. 43 Thus, \$3,612,230 was used as the estimate the economic value of a human life (to life expectancy) in the equation.

The median age at death for causes attributed to secondhand smoke exposure was subtracted from the average U.S. life expectancy of 77.8 years for 2004 ⁴⁴ and divided by this average life expectancy (77.8 years) to determine the percent of life lost. This percent of life lost was multiplied by the value of life estimate and then multiplied by the number of secondhand smoke attributable deaths for each illness to obtain an estimated dollar value for the secondhand smoke-attributable loss of life.

Limitations in Estimating SHS Adult Mortality Costs: There are several limitations related to estimating of the costs of adult mortality from second hand smoke exposure. First, only those diseases with well-documented attributable risks for secondhand smoke exposure were included in our application. Second, it was assumed that the attributable risk values found in the published literature apply to the Indiana population. A third concern is that there may not be agreement on the actual value of a full life, since this is a difficult and subjective variable to quantify. Fourth, this model used the life expectancy at birth, which provides a conservative estimate of the proportion of life lost. A more accurate measure would be to use life expectancy at the time the individual began being exposed to secondhand smoke; however, that age was unknown.

Secondhand Smoke Child Morbidity and Mortality Costs:

The model for estimating child morbidity and mortality was structured differently to take advantage of the data provided by Aligne and Stoddard.⁴ The first step was to

estimate the number of events in children using a ratio of the values provided by Aligne and Stoddard to the U.S. population for the particular age group, using this formula:

$$E_{SC} = P_{SC} * (E_{US}/P_{US})$$

Where:

 E_{SC} is the estimated number of events in the sub-population of children in Indiana for the applicable disease;

 P_{SC} is the number in the applicable sub-population of children in Indiana based on the US Census estimates of children living in Indiana during 2007;

 E_{US} is the number of events in the U.S. for the disease in the applicable subpopulation; and,

 $P_{\rm US}$ is the number in the applicable sub-population based on the US Census reported estimates of children living in the US during 2007.

This calculation was used to determine an estimate of the initial number of events for the Indiana population. The attributable risk estimates, also reported by Aligne and Stoddard, ⁴ were then applied to the estimated number of events in Indiana. An estimate of the number of events among Indiana youth that can be attributed to secondhand smoke exposure was then obtained using the formula:

$$E_{SHS} = AR * E_{SC}$$

Where:

 E_{SHS} is the number of events in Indiana attributable to secondhand smoke;

AR is the secondhand smoke attributable risk of getting the disease if exposed to secondhand smoke; and

 E_{SC} is the estimated total number of events in Indiana among both the exposed and non-exposed applicable sub-populations.

Before applying the costs per case estimates reported by Aligne and Stoddard ⁴ to the number of events, the costs were adjusted to year 2007 dollars, using the medical care category of the consumer price indices established by the US Department of Labor. ⁴³ Finally, the cost estimates for the secondhand smoke attributable events were determined by multiplying the costs per event by the number of secondhand smoke attributable events in Indiana, using the formula:

$$C_{SHS} = C_E * E_{SHS}$$

Where:

 C_{SHS} is the cost of disease attributable to secondhand smoke in Indiana; C_E is the cost per event (doctor's visit, hospitalization, surgery, etc.) for each disease adjusted to 2007 U.S. dollars; and,

 E_{SHS} is the number of events related to each of the diseases in Indiana attributable to secondhand smoke.

The Aligne and Stoddard⁴ data included the number of office visits, hospitalizations, surgeries and deaths of each secondhand smoke-related pediatric illness. Their data were used because outpatient and surgery data were not available for Indiana.

Limitations in Estimating SHS Costs in Children: The method used to estimate the costs of exposure to secondhand smoke for children relies heavily on the data presented in the Aligne and Stoddard⁴ article. The findings in their study (attributable risk, utilization, and cost of care) may not be representative of Indiana in a different year, although that assumption is made for this study. Also, the diseases included in their

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analysis may not be exhaustive of diseases that can be attributed to secondhand smoke exposure. Thus, using only the diseases and conditions in their study would underestimate the actual costs of secondhand smoke exposure. Also, the Aligne and Stoddard⁴ study did not include all sources of health care, such as emergency room and pharmacy costs, which, if included, would have increased the cost of these diseases significantly. Finally, the cost of pain and suffering of the children and their parents were not included in their study; thus, they were also omitted from this model.

RESULTS

The 2006 hospital discharge data for adults were obtained from the Indiana State Department of Health and used to estimate hospitalization costs for conditions attributed to secondhand smoke in 2007. The numbers of discharges for the seven conditions attributable to secondhand smoke for adults are shown in Table 1. While morbid conditions result in many types of contacts with the health care system (doctor's visits, hospitalizations, pharmacy, etc.), only hospitalization data were available for the adult population in Indiana. The 2006 hospital discharge costs were adjusted to year 2007 dollars using the medical care category of the consumer price index from 2006 to 2007.

Mortality statistics for adults were provided by the Indiana State Department of Health for the study year. The deaths for the causes attributable to secondhand smoke exposure are shown in Table 1. The mortality statistics were also used to determine the median ages at death from these causes, which were needed to calculate the cost of loss of life.

Table 2 presents the estimated incidence of morbidity and mortality for secondhand smoke related medical conditions among children. The number of deaths and

low birth weight deliveries were obtained from the birth and death records provided by the Indiana State Department of Health. The number of children receiving health care (hospitalizations, office visits, and surgeries) was determined by applying the estimated number of children in Indiana derived from the 2007 U.S. Census estimates to rates calculated from numbers published in the Aligne and Stoddard article.⁴ For example, the number of office visits for otitis media for children less than 14 years old, as reported by Aligne and Stoddard, ⁴ was divided by the total number of children less than age 14 in the United States (using 2007 census data) to get a national rate of office visits by children in this age group with otitis media. This rate was then multiplied by the total number of children less than 14 years of age in Indiana from the 2007 census to obtain the estimated number of office visits for otitis media in Indiana (18,261).

Secondhand Smoke Adult Morbidity and Mortality Costs:

Table 1 presents the estimated incidence, attributable risk, and costs of health care and loss of life of secondhand smoke related medical conditions for adults. The overall cost of hospitalizations for adults in Indiana attributed to secondhand smoke was estimated to be \$214,226,986 in 2007. The loss of life costs for these same conditions was estimated to be \$66,269,313 in 2007. Combined, the secondhand smoke morbidity and mortality costs for adults attributed to secondhand smoke totaled \$280,496,299 in 2007.

Secondhand Smoke Child Morbidity and Mortality Costs:

Table 2 presents the estimated incidence, attributable risk, and costs of health care and loss of life for secondhand smoke related medical conditions for children. The overall costs of health care for children were estimated to be \$68,310,521 in 2007. The

estimated loss of life costs for these same conditions were \$41,480,827 in 2007.

Combined, the secondhand smoke attributable morbidity and mortality costs for children were estimated to total \$109,791,348 in 2007.

Thus, the total economic impact on the health of Indiana residents was estimated to be \$390,287,647 in 2007. Since the 2007 population of Indiana was estimated to be 6,345,289,⁴⁵ the total per capita health cost of secondhand smoking in Indiana was estimated to be \$61.51 per person in 2007.

DISCUSSION

Exposure to secondhand smoke is not only a significant health concern, but a significant economic concern as well. The purpose of this study was to provide a model to estimate the health-related costs of secondhand smoke exposure on a State level. It was estimated that about \$282.5 million were spent in Indiana for the hospitalization and health care of patients with diseases attributed to secondhand smoke exposure in 2007. Additionally, in 2007 approximately \$107.8 million was lost due to premature death that can be attributed to secondhand smoke exposure. The total cost (health care costs and the cost of premature loss of life) for diseases attributed to secondhand smoke in Indiana was estimated to be \$390.3 million in 2007 or about \$61 per person. These costs do not include the health care and loss of life costs of Indiana residents who are smoking, which are estimated to be over \$2 billion. 46

It is widely known that tobacco use contributes to the increased incidence of disease and premature loss of life in those who smoke; however, many do not recognize the impact of a person's smoking on his or her spouse, children, family members, friends, co-workers and customers. The adult smoking rates in Indiana are higher than the nation

as a whole. While the rate of smoking among adults in the U.S. is 19.8 percent, Indiana's adult smoking rate was 24.1 percent in 2006.⁴⁷ It has been estimated that nearly 60 percent of the US population is exposed to second hand smoke in their homes.³ Since the adult smoking rate in Indiana is higher than the national average, it is reasonable to infer that adults and children in Indiana are exposed to SHS at a higher rate as well.

The health-related costs arising from secondhand smoke exposure could be avoided or reduced in two ways. First and most obvious, the individual should quit smoking. Second, those who continue to smoke tobacco should be discouraged from smoking in their home, their automobile and their workplace. Policies should be enacted and strictly enforced to prohibit smoking in all inside areas. Business owners and managers should also consider making their places of business smoke-free. Such policies need to have the support of the public and employees, which requires that they understand the magnitude of the consequences of secondhand smoke both from a health perspective as well as from an economic perspective. In a survey of 20 states measuring attitudes about secondhand smoke, Indiana was among the states having the lowest public support favoring restrictions on smoking, including smoke-free policies in work areas, no smoking in restaurants and prohibiting indoor smoking work areas.

Although Indiana is making good progress to protect citizens from the hazards of SHS with

- 36 newly passed local laws of which over three-fourths (77%, n=28) meet the
 Surgeon General's Report, 2006, conclusion that eliminating smoking in indoors
 spaces fully protects nonsmokers from exposure to secondhand smoke;
- 40% of Indiana residents now being protected to some degree by smoke-free

laws;

- 28% of Hoosiers being protected by <u>strong</u> smoke-free laws;
- 76 of 92 counties having school districts that are either completely or partially smoke-free;
- 13 major university or college campuses being smoke-free; and,
- most governments and hospitals being smoke-free,

the high incidence of smoking and the relatively weak policies and poor attitudes related to secondhand smoke, Indiana is at high risk for continuing to incur high secondhand smoke related costs if more effective public policies related to secondhand smoke are not developed, supported, and implemented.

The costs of secondhand smoke should be considered when developing policy recommendations to combat the effects of tobacco smoking on a population. The costs of morbidity and mortality associated with secondhand smoke are directly or indirectly borne by many. Employers bear additional costs for health insurance premiums, and self-insured employers may bear the full cost for employees and their families. Employers additionally bear many of the indirect costs associated with tobacco use and secondhand smoke. Consumers may bear costs of secondhand smoke associated with their portion of insurance premiums and additional coinsurance and/or co-payments associated with the hospitalization, physician and pharmaceutical costs. Society bears the cost burden for the uninsured population through the large amount of uncollected hospital revenues; taxpayers bear the cost of Medicaid benefits for indigents and for Medicare. Additionally, society as a whole bears the burden of loss of life. The lost productivity and opportunity

cost of losses related to contributions to society that would have been made are borne for many years.

It is important to use these data to educate consumers, business owners, legislators and policy makers to make them more aware of the huge economic consequences of secondhand smoke at the community level. It is the role of policy makers and government agencies to protect the health of its citizens and to promote the economic prosperity of the community.

Policy recommendations resulting from this study include the following:

- Encourage the use of these findings to further educate the public, as well as community leaders and policy makers, about the health impacts and costs of secondhand smoke in Indiana;
- Encourage businesses and institutions to totally eliminate smoking at the workplaces, on their campuses including schools, colleges and universities, day care centers, restaurants and other food or beverage service establishments;
- Strictly enforce no smoking restrictions in all public areas, and on business and school campuses;
- Provide more support for smoking cessation by businesses, health departments and health care providers; and.
- Encourage smokers not to smoke in shared areas.

SO WHAT?

This report presents an estimate of the cost of health care and the cost of premature loss of life for diseases attributed to secondhand smoke in Indiana. The model was applied to data for Indiana, providing a cost estimate of \$390.3 million in 2007.

Although a number of assumptions and limitations were made, this model provides a useful cost estimate of the impact of secondhand smoke exposure. All of the components of the model should be readily available in most communities. Some health promotion professionals may have access to more specific information on health care costs, may want to use other estimates for the value of life, may want to include additional diseases, or may want to use updated attributable risk values when they become available; thus, adapting this model to their needs. These cost estimates will provide data needed to educate the public and community leaders about the health effects and costs of secondhand smoke exposure.

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